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(54) HEATED NOZZLE BUSHING WITH FIXED SPIRAL BLADE

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BACKGROUND OF THE INVENTION

This invention relates to injection molding and more particularly to an improved electrically heated nozzle bushing which imparts a curving motion to the melt entering the cavity.

It is well known that molecular orientation effects the strength of injection molded plastic products. Orientation is generally thought to be caused by flow of polymer in the direction of least resistance where stresses induced are generally parallel to the flow direction. This resulting unidirectional orientation causes the molded product to be stronger to resist bending forces along the direction of orientation and weaker to resist bending forces across the direction of orientation. For instance, a center-gated coffee cup would be stronger in the vertical direction, but very weak in the hoop direction. On the other hand, it is well known to form plastic film with a biaxial molecular orientation to improve its strength characteristics.

More recently, rotation of the mold has been used in injection molding to form the product with a biaxial or multiaxial molecular orientation. While this has been successful in achieving increased product strength, it is not a practical solution to the problem because of difficulties in constructing and operating the spinning molds. It is not suitable for multicavity application, and is very difficult for irregular shaped products.

Even more recently, attempts have been made to achieve biaxial or multiaxial molecular orientation by designing the mold cavity to provide the inflowing melt with an irregular flow pattern. This has usually been in the form of ribs or other shapes against which the incoming melt impinges to spread or

disperse it in different directions. While having better results in terms of increased product strength, this method or concept, of course, has the disadvantage that the product must include the ribs or other shapes introduced into the design to provide this filling action. Needless to say, this is not satisfactory for a large range or products.

The applicant's copending Canadian application serial number 352,349 filed May 21, 1980 discloses an injection molding system with an improved nozzle tip portion to overcome these problems, but it is for valve-gating. Sprue gated systems have traditionally had the problem or concern of reducing or eliminating stringing of the melt from the gate when the mold opens to eject the product from the cavity.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to at least partially overcome these disadvantages by providing an injection molding nozzle system wherein a swirling motion is imparted to the melt entering the cavity to reduce unidirectional molecular orientation of the molded product.

To this end, in one of its aspects, the invention provides an injection molding nozzle bushing comprising: a hollow elongated body having a runner passage extending longitudinally therethrough from an inlet to an outlet at opposite ends thereof; elongated heating means adapted to heat the elongated body; and a spiral blade member fixed in position in the runner passage to extend to the outlet thereof.

In another of its aspects, the invention provides an injection molding nozzle bushing comrpising: a hollow elongated inner core portion having an inner surface defining a generally cylindrical central runner passage extending longitudinally

therethrough from an inlet to an outlet at opposite ends thereof, the core portion being formed of a high strength, corrosion resistant thermally conductive material; an elongated electric heating element extending around the inner core portion; an elongated conductive portion cast on the inner core portion and the heating element to be bonded to them along at least a portion of their lengths; and a spiral blade member fixed in position in the central runner passage to extend to the outlet thereof.

In yet another of its aspects, the invention further provides an injection molding nozzle bushing comprising: a hollow elongated inner core portion having an inner surface defining a central runner passage extending longitudinally therethrough from an inlet to an outlet at opposite ends thereof, the central runner passage being generally cylindrical with a tapered portion which gradually decreases in diameter towards the outlet, the inner core portion being formed of a high strength, corrosion resistant, thermally conductive metal; an electrically insulated helical heating element having a plurality of spaced coils encircling the inner core portion and terminal means adapted to receive electric power from an external source; an elongated conductive portion cast on the inner core portion and the heating element to be bonded to them along their lengths, the conductive portion being formed of a metal having a high thermal conductivity; a spiral blade member extending in the central runner passage from the inlet to the outlet, the sprial blade member being attached along its edges to the inner surface of the inner core portion, the spiral blade member being formed of corrosion resistant material and gradually decreasing in pitch and thickness adjacent the outlet; an elongated outer sleeve portion formed of a corrosion resistant metal extending

around the conductive portion; and retaining means adapted to retain the nozzle bushing against rotation.

Further objects and advantages of the invention will appear from the following description, taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a partial cut-away perspective view of an injection molding system having a nozzle bushing according to a preferred embodiment of the invention; and

Figure 2 is a sectional view of the same embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, the injection molding system has a nozzle bushing 10 which is seated in a cavity plate 12 and a back plate 14. The nozzle bushing 10 provides a hot runner passage 16 through which hot pressurized melt flows from a molding machine (not shown) to a cavity 18.

The nozzle bushing 10 has an inner core portion 20 with an inner surface 22 which forms the hot runner passage 16 extending from an inlet 24 to an outlet 26 which is the gate to the cavity 18. As may be seen, the passage 16 is generally cylindrical except for a beveled portion 28 at the inlet 24 to receive the molding machine and a tapered portion 30 at the outlet 26. Surrounding the inner core portion 20 is an electric helical heating element 32 which is cast in a conductive portion 34. The heating element 32 is insulated from the surrounding material and in this embodiment is shown as of double core construction extending to an external lead 36 for connection to a source of electric power (not shown). The coils of the heating element 32 are separated from each other to provide for maximum bonding of the conductive material forming conductive

portion 34 to the surface of the coils as well as to the outer surface 38 of the inner core portion 20. An outer sleeve portion 40 around the conductive portion 34 provides a corrosion resistant outer finish.

The nozzle bushing 10 also includes a spiral blade member 42 which extends through the hot runner passage 16 from the inlet 24 to the outlet or gate 26. The spiral blade member 42 is brazed along its outer edges 44 to the inner surface 22 of the inner core portion 20 to securely fix it in position. The blade member is formed of sufficient thickness to ensure it does not rupture during use, but its thickness is gradually reduced adjacent the outlet 26 to minimize the restriction when the melt passes through the tapered portion 30 and the gate 26. Furthermore, the blade member spiral gradually decreases in pitch in this same area to increase the swirling motion imparted to the melt as it enters the cavity.

The nozzle bushing 10 is securely mounted in the cavity plate 12 and back plate 14 by insulation bushing portion 46. The cavity plate 12 which is cooled by cooling element 48 is separated from the heated nozzle bushing 10 by air gaps 50 to reduce heat losses. The outer end 52 of a pin 54 seated in a hole 56 in the nozzle bushing 10 is received in a slot 58 in the back plate 14 in order to prevent rotation of the nozzle bushing by the force of the melt on the spiral blade member 42.

In use, the nozzle bushing 10 is located in the mold between the molding machine and the cavity 18. Power is applied to the heating element 32 through lead 36 and operation commences after the nozzle bushing is heated up. Pressurized melt from the molding machine is injected through the hot runner passage 16. Melt pressure is applied from the molding machine in

impulses. After the application of each pressure impulse to fill the cavity, the melt solidifies in the area of the gate 26 and the mold is opened to eject the molded product and then closed again before the next pressure impulse. Temperature control is very critical to dependable operation, particularly in the gate area. Sufficient heat must be provided by the heating element 32 to maintain smooth, even melt flow, without preventing the cooling element 48 from cooling the cavity and gate sufficiently to provide for rapid solidification and ejection. When a pressure impulse is applied, the melt flows rapidly through the not runner passage 16 and the spiral shape of the blade member 42 imparts a swirling motion to the melt as it passes through the gate 26 into the cavity 18. This swirling motion of the melt through the gate is accelerated by the gradually decreasing pitch of the spiral blade member so that it is carried as far as possible into the cavity 18 to provide the whole product with the increased strength resulting from unidirectional moledular orientation of the melt being avoided. In addition, this curving motion of the melt as it leaves the gate has the effect of reducing stringing of the melt when the mold opens to eject the product, presumably because the molecular orientation of the melt is no longer generally perpendicular to the parting line.

In the preferred embodiment, the inner core portion 20 is formed of a corrosion resistant material such as stainless steel to withstand corrosive effects of some melts, as well as to provide the necessary strength. The outer sleeve portion 40 is also formed of stainless steel to provide a durable finish and to withstand any corrosive gases escaping from the gate area. The spiral blade member 42 is formed of high strength steel and

the conductive portion 34 is formed of copper which is cast over the heating element 32 and thereby bonded to the surface of the coils as well as to the outer surface 38 of the inner core portion 20. The copper is highly conductive and this integral structure provides for the rapid transfer of heat from the coils of the heating element 32 and its generally uniform application to the outer surface 38 of the inner core portion 20. This structure provides the necessary strength to withstand the repeated high pressure loading while allowing the thickness of the lesser conductive inner core portion 20 to be minimized. Thus there is uniform heat application to the melt along the length of the nozzle bushing, while avoiding temperature build-ups which could result in the heating element burning-out or deterioration of the melt. The surfaces of the stainless steel blade member 42 are smooth to reduce friction losses with the melt as well as to avoid any "dead spots".

Although the description of this invention has been given with respect to a single embodiment, it is not to be construed in a limiting sense. Many variations and modifications will now occur to those skilled in the art. In particular, other blade configurations could be used, for instance only having it extend along part of the length of the hot runner passage 16 ending at the gate 26. Additional pins 54 or other means could be used to prevent rotation of the nozzle bushing, and alternate materials could be used for various molding applications. For a definition of the invention, reference is made to the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An injection molding nozzle bushing comprising:
   (a) a hollow elongated body having a runner passage extending longitudinally therethrough from an inlet to an outlet at opposite ends thereof;
   (b) elongated heating means adapted to heat the elongated body; and
   (c) a spiral blade member fixed in position in the runner passage to extend to the outlet thereof.

2. An injection molding nozzle bushing comprising:
   (a) a hollow elongated inner core portion having an inner surface defining a generally cylindrical central runner passage extending longitudinally therethrough from an inlet to an outlet at opposite ends thereof, the core portion being formed of a high strength, corrosion resistant thermally conductive material;
   (b) an elongated electric heating element extending around the inner core portion;
   (c) an elongated conductive portion cast on the inner core portion and the heating element to be bonded to them along at least a portion of their lengths; and
   (d) a spiral blade member fixed in position in the central runner passage to extend to the outlet thereof.

3. An injection molding nozzle bushing as claimed in claim 2 wherein the spiral blade member is secured to the inner surface of the inner core portion and extends from the inlet to the outlet.

4. An injection molding nozzle bushing as claimed in claim 3 further comprising:

(e) an elongated outer sleeve portion formed of a corrosion resistant material extending around the elongated conductive portion.

5. An injection molding nozzle bushing as claimed in claim 2, 3 or 4 further comprising receiving means adapted to receive retaining means to retain the nozzle bushing against rotation.

6. An injection molding nozzle bushing as claimed in claim 2, 3 or 4 wherein the heating element is helical, having a plurlaity of spaced coils encircling the inner core portion with terminal means adapted to receive electrical power from an external source.

7. An injection molding nozzle bushing as claimed in claim 2 wherein the central runner passage has a tapered portion which gradually decreases in diameter towards the outlet.

8. An injection molding nozzle bushing as claimed in claim 2 wherein the spiral blade member gradually decreases in pitch adjacent the outlet of the central runner passage.

9. An injection molding nozzle bushing as claimed in claim 7 wherein the spiral blade member gradually decreases in pitch adjacent the outlet of the central runner passage.

10. An injection molding nozzle bushing as claimed in claim 2, 4 or 9 wherein the spiral blade member gradually decreases in thickness adjacent the outlet of the central runner passage.

11. An injection molding nozzle bushing comprising:

(a) a hollow elongated inner core portion having an inner surface defining a central runner passage extending longitudinally therethrough from an inlet to an outlet at opposite ends thereof, the central runner passage being generally cylindrical with a tapered portion which gradually decreases in diameter towards the outlet, the inner core portion being formed of a high stength, corrosion resistant, thermally conductive metal;

(b) an electrically insulated helical heating element having a plurality of spaced coils encircling the inner core portion and terminal means adapted to receive electric power from an external source;

(c) an elongated conductive portion cast on the inner core portion and the heating element to be bonded to them along their lengths, the conductive portion being formed of a metal having a high thermal conductivity;

(d) a spiral blade member extending in the central runner passage from the inlet to the outlet, the spiral blade member being attached along its edges to the inner surface of the inner core portion, the spiral blade member being formed of corrosion resistant material and gradually decreasing in pitch and thickness adjacent the outlet;

(e) an elongated outer sleeve portion formed of a corrosion resistant metal extending around the conductive portion; and

(f) retaining means adapted to retain the nozzle bushing against rotation.

12. An injection molding nozzle bushing comprising:

(a) a hollow elongated body having an inner surface defining a generally cylindrical central runner passage extending longitudinally therethrough from an inlet to an outlet at opposite ends thereof;

(b) elongated heating means adapted to heat the elongated body; and

(c) a spiral blade member formed of a corrosion resistant material extending in the central runner passage from the inlet to the outlet, the spiral blade member being brazed along its edges to the inner surface of the elongated body.

ABSTRACT OF THE DISCLOSURE

This invention relates to a nozzle bushing for a sprue gated injection molding system. The elongated nozzle bushing has a hollow stainless steel inner core portion through which extends the runner passage from the molding machine to the cavity gate and around which is located a helical electric heating element. A highly conductive copper portion is cast over the heating element and the inner core portion, and covered by a stainless steel outer sleeve. A steel spiral blade member is fixed in the runner passage to impart a curving or swirling motion to the melt as it flows from the gate into the cavity. This provides the advantage of improving product strength by reducing unidirectional molecular orientation of the melt, as well as reducing stringing of the melt when the mold opens to eject the product.

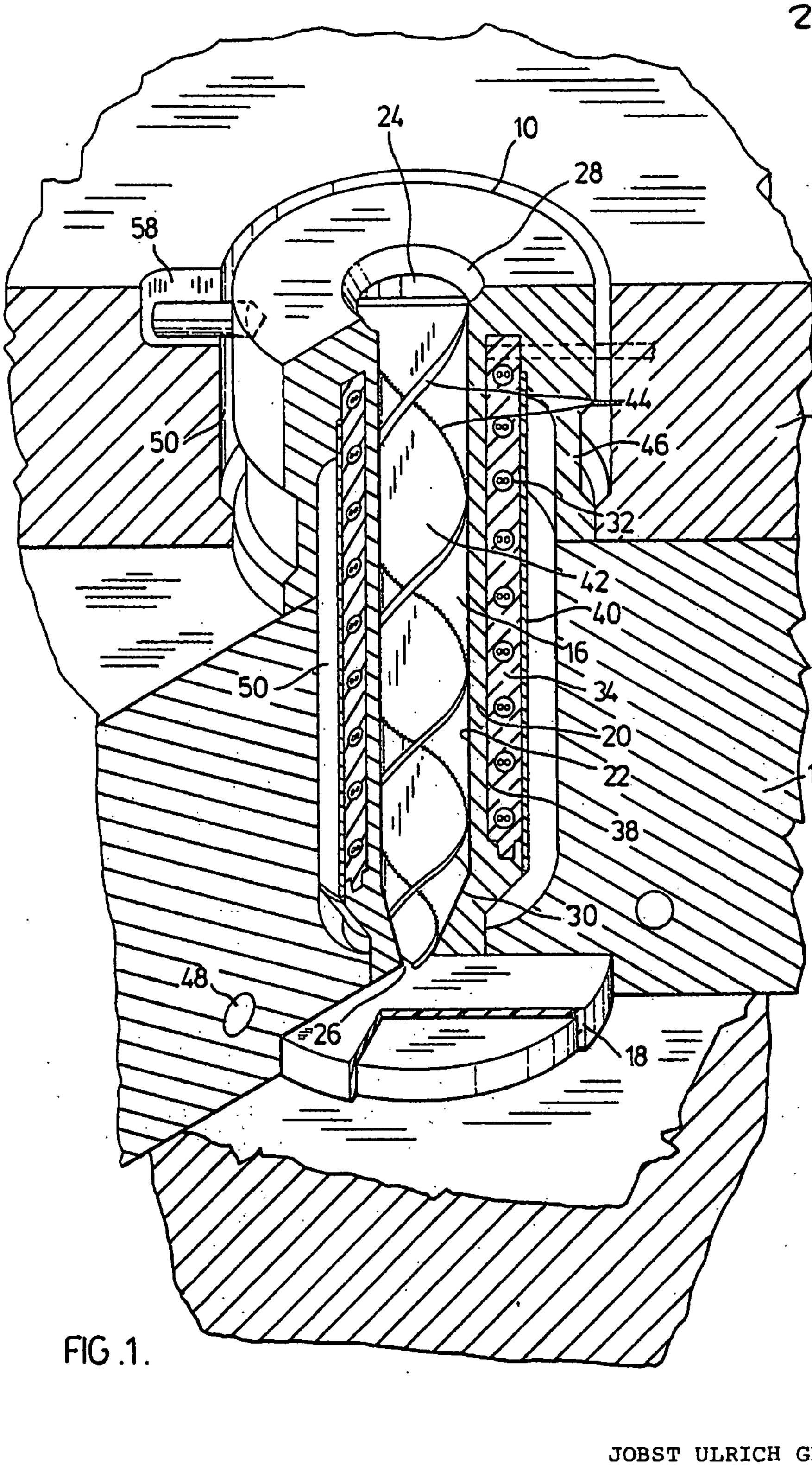

FIG.1.

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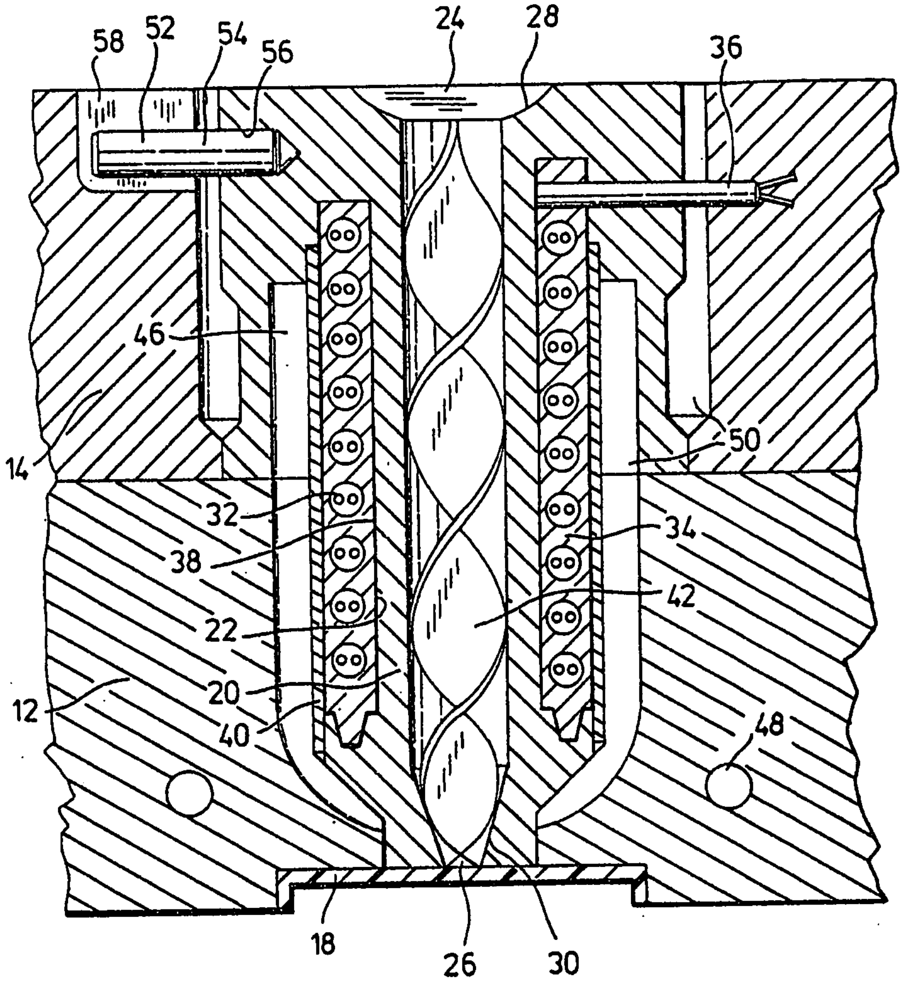

FIG. 2.

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